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Efficacy Of Three Injected Chemical Systems For Control Of The Southern Pine Beetle

By: M. J. Dalusky, C. W. Berisford and P. B. Bush

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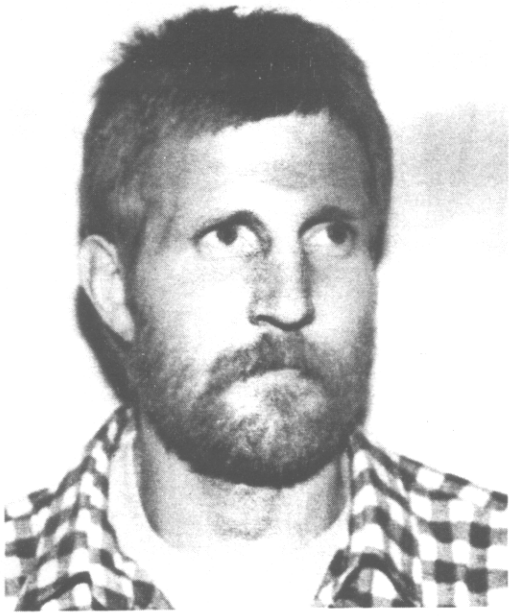
About The Authors



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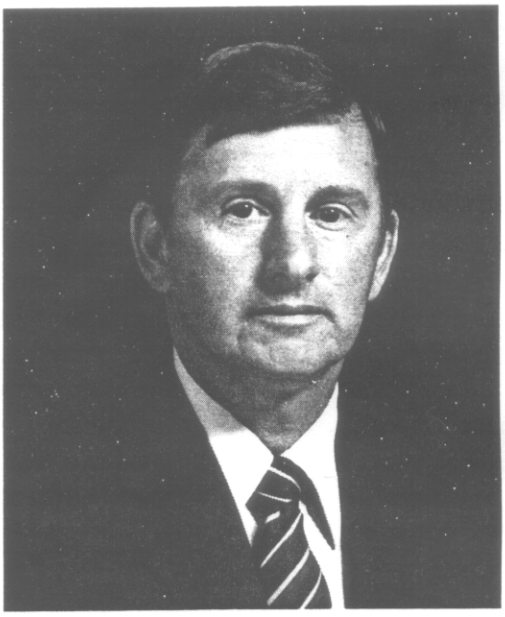

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Efficacy Of Three Injected Chemical Systems For Control Of The Southern Pine Beetle

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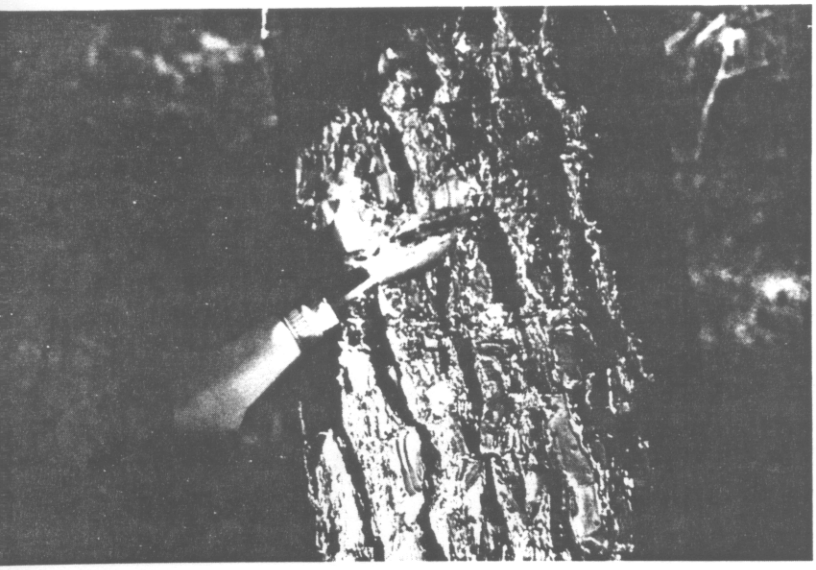

Figure 1. Implementation of Pestroy 'hack and squirt' method of injection.

Figure 2. Mauget injector method for application of systemics.

INTRODUCTION

The southern pine beetle (SPB), *Dendroctonus frontalis* Zimmermann, is one of the most serious pests of southern pines. It represents a threat to both commercial forests and high value trees such as pines in yards, parks, seed orchards etc. (Price and Doggett 1978, Thatcher et al. 1978). Current technology for mitigating SPB damage involves: 1) salvage, 2) cut and leave, 3) pile and burn or 4) direct chemical control. All of these options are labor intensive, require the use of heavy or specialized equipment, and are subject to vagaries of weather and market constraints. Also, potential environmental concerns and non-target impact of some suppression tactics may further reduce control options in the future.

The recent availability of some new chemicals and/or innovative techniques for their use has raised hopes for an effective, economical and relatively safe way to prevent attacks or to control expansion of existing SPB infestations (spots). Two available formulations are currently registered for use.

Fenitrothion (Pestroy^{R} formulation) is employed in a 'hack and squirt' technique whereby the undiluted formulation is injected into ax frills or 'hacks' placed around the circumference of trees under attack in SPB infestations (Fig. 1), (Billings and Goyer 1987). The rationale is that the active ingredient will be translocated up the trunk and attacking beetles and/or developing brood will ingest a lethal dose,thereby slowing or arresting spot growth. Unattacked trees are treated in a buffer zone, similar to that used for salvage or 'cut and leave' treatments, enclosing the active front (head) of the spot.

The second system currently available is the Mauget Injector^{R} (Injecticide). This technique employs prepackaged, pressurized containers of insecticide such as dicrotophos (Bidrin^{R} formulation) attached to spouts placed in drill holes at the root flare of the tree (Fig. 2) with 3-6 injectors per tree.

A third technique, still in the experimental phase, employs a combination of the fumigant, sodium N-methyldithiocarbamate (SMDC, Vapam^{R} formulation) and dimethyl sulfoxide (DMSO) applied to bark hacks on trees at the head of infestations as per Pestroy treatment (Fig. 1). It has undergone limited testing under the provisional names "Vardamite" and "Rotonicide". This system apparently relies on the induction of defensive reactions in treated trees instead of direct toxicity from the chemicals applied (L. H. Roton, pers. comm.).

Another experimental method, using dicrotophos applied to bark hacks as in the Pestroy technique, was also evaluated.

We report here, preliminary tests of the above techniques to determine the distribution and longevity of these chemicals within treated trees and their impact on SPB attack densities, brood production and tree mortality.

MATERIALS AND METHODS

Efficacy Tests

During the summer of 1987, groups of trees (reps) were treated at the head of SPB infestations with fenitrothion in bark hacks, SMDC-DMSO in bark hacks, bark hack only (BHO), dicrotophos in Mauget Injectors and untreated controls. Bark hacks were made at breast height and were ca. 4 inches long by one inch deep. Pesticide was applied at the rate of 0.13 and 0.26 oz. per hack for fenitrothion and SMDC/DMSO, respectively and .003 oz. per injector for dicrotophos. Tests were replicated 5 times.

After allowing 5 to 7 days for insecticide translocation, trees were baited with the southern pine beetle attractant 'frontalure' (frontalin: alpha pinene, 1:2) to help insure mass attack. In the latter stages of SPB brood development, the trees were felled and bolts removed from low (3ft. above injection point), mid, and top (3 ft. below live crown) sample heights. Half of each sample was reared in ventilated containers at ca. 80° F, and all emerging beetles were counted. The other half of each bolt was stripped of bark and SPB egg gallery length measured for two randomly selected 40 $in.^2$ areas.

In 1988, 4 replicates were treated with SMDC-DMSO and dicrotophos in bark hacks, these being the two most promising candidates for further testing. Bark hack only (BHO) and untreated trees were included as internal standard and control. Only brood production was determined for these tests.

Pesticide Residues

A series of experiments was initiated in Spring of 1987 to measure the movement potential and residual nature of the toxicants within loblolly pine. A group of trees was treated with one of the 3 systems as previously described, then felled, and samples for residue analysis were removed from the low, mid and top height levels along the bole. Trees were sampled initially at 1, 4, 7, and 14 days post-treatment. In a second test in the summer of 1987, day 4 was deleted and day 21 added.

Samples from both phloem and xylem were collected, returned to the laboratory and held in a freezer at 14°F. Samples were analyzed via gas chromatography (GC) for pesticide residues. Phloem was separated from the sapwood for each sample and the bark was removed. For dicrotophos and fenitrothion, the phloem strips were then ground in a Wiley mill and soxhlet extracted in ethyl acetate overnight. Xylem samples were drilled with a 5/8" wood bit to a depth of 1 in. and the resultant chips extracted as described above. Residue levels were analyzed using a Tracor Model 565 gas chromatograph (GC) equipped with a Tracor FPD detector (P mode) and dual 2 meter standard packed Columns (Column 1: 3% OV-1 on 100/120 Supelcoport; Column 2: 2% OV-17/1% OV210 on 100/120 Supelcoport; Column oven temp.=392°F).

The extracts were initially screened on the V-1 Column. Positive residues were confirmed by analysis utilizing the SPB-35 column. All residue levels were quantified by comparison of sample peak heights with known analytical standards. A reagent blank and spiked samples were included with each set of analyses. Average recoveries ranged from 92 to 108%.

For SMDC analysis, the phloem and xylem samples were prepared as previously described. The wood chips were extracted with water overnight. Salt (NaCl) was added to the aqueous extract and the SMDC was extracted with ethyl acetate. Water was removed from the organic layer with sodium sulfate and the extract was analyzed by gas chromatography.

SMDC residue levels were analyzed using a Tracor Model 565 Gas Chromatograph equipped with Tracor NP Detector (Nitrogen-Phosphorous Specific) and dual 30 meter large bore (0.53 mm) capillary columns. The two columns consisted of Supelco SB-5 and SPB-35. The oven temperature was 158°F.

The extracts were initially screened on the SPB-5 Capillary Column. Positive residues were confirmed and quantified as previously mentioned. Average recoveries for reagent blank and spiked samples ranged from 65 to 85%.

In the summer of 1988, an additional movement potential test was performed for SMDC/DMSO, and dicrotophos, both in bark hacks. Residue samples at each height were taken at 1, 5, 10 and 24 hours post-treatment, and again on day 4 and weeks 1, 2, 4, 8, 10, 12, 14 and 20. Sampling protocol was slightly modified in that phloem and xylem were separated in the field and placed immediately on dry ice to prevent loss via volatilization, and transported to the lab. Samples were analyzed for residues as previously described.

RESULTS AND DISCUSSION

Brood Production and Gallery Length

Tests conducted in 1987 showed that Dicrotophos treated billets (Mauget injectors) produced fewer beetles than any other treatment (Fig. 3). Similarly, less egg gallery length per unit area was excavated in these bolts. SMDC/DMSO was the next 'best' treatment, achieving brood and gallery length reduction between that of dicrotophos and BHO treatments. Fenitrothion treatment was in no case different from untreated or BHO replicates.

In 1988, brood production from treated bolts followed a similar trend, but differences were even more dramatic (Fig. 4). Dicrotophos treatment (in bark hacks) drastically reduced brood production. SMDC/DMSO was not significantly different from the BHO treatment. Both of these treatments yielded significantly lower SPB densities relative to untreated billets.

Pesticide Residues

Residue analyses in 1987 showed that fenitrothion moved very little from the point of injection (Fig. 5). SMDC/DMSO was present in the xylem at low levels for a maximum of 2 weeks, but little was found in the phloem. Dicrotophos was found in the xylem and phloem in relatively high concentrations (Fig. 5) for at least 1 day then dissipated rapidly to lower levels where residues were detected for up to 21 days. Even at the lowest concentration, dicrotophos residues were greater than the highest (Day 1) level of SMDC/DMSO. Also, there apears to be an outward leaching of dicrotophos into the contiguous phloem after day 4, which could account for its efficacy against developing broods.

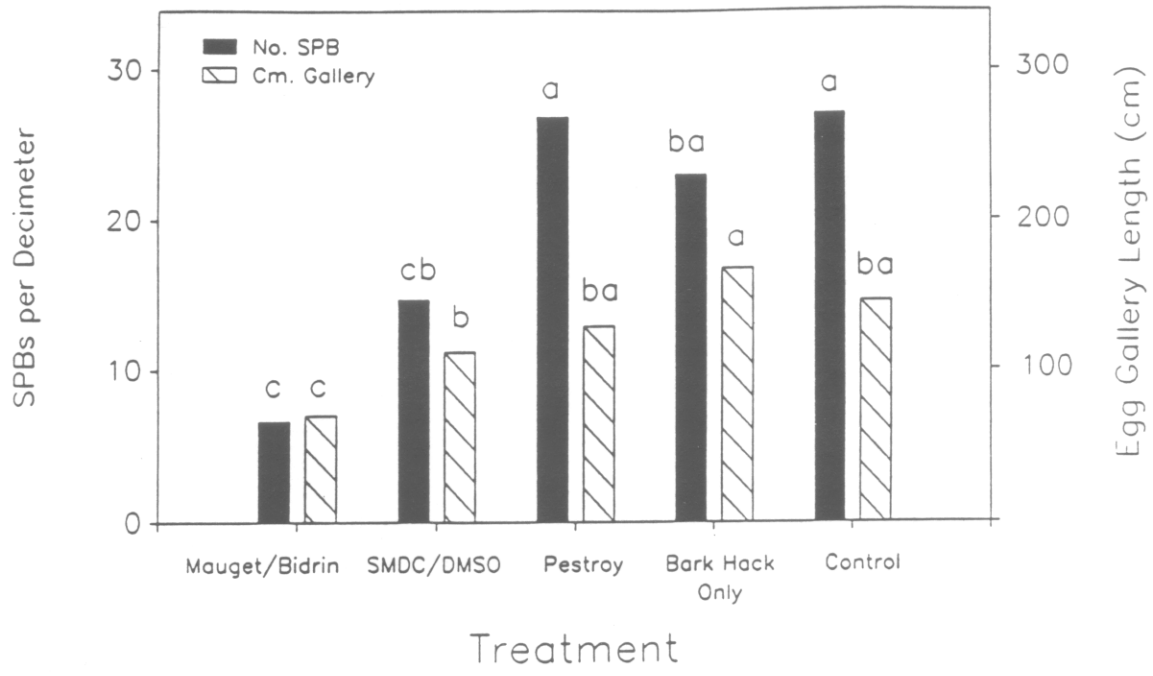

Figure 3. Brood production and egg gallery length in treated and control trees, 1987. (bars in the same legend with same letters not significantly different, alpha=0.05)

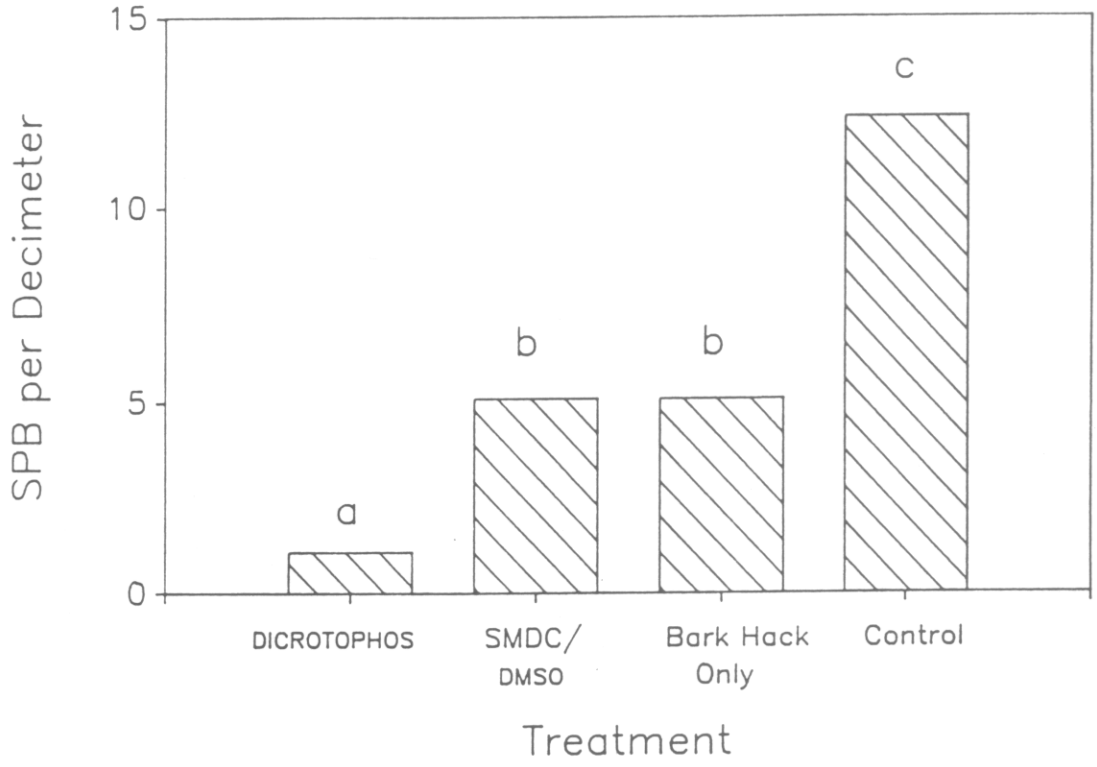

Figure 4. Brood production in treated and control trees, 1988. (bars with same letters not significantly different, alpha=0.05)

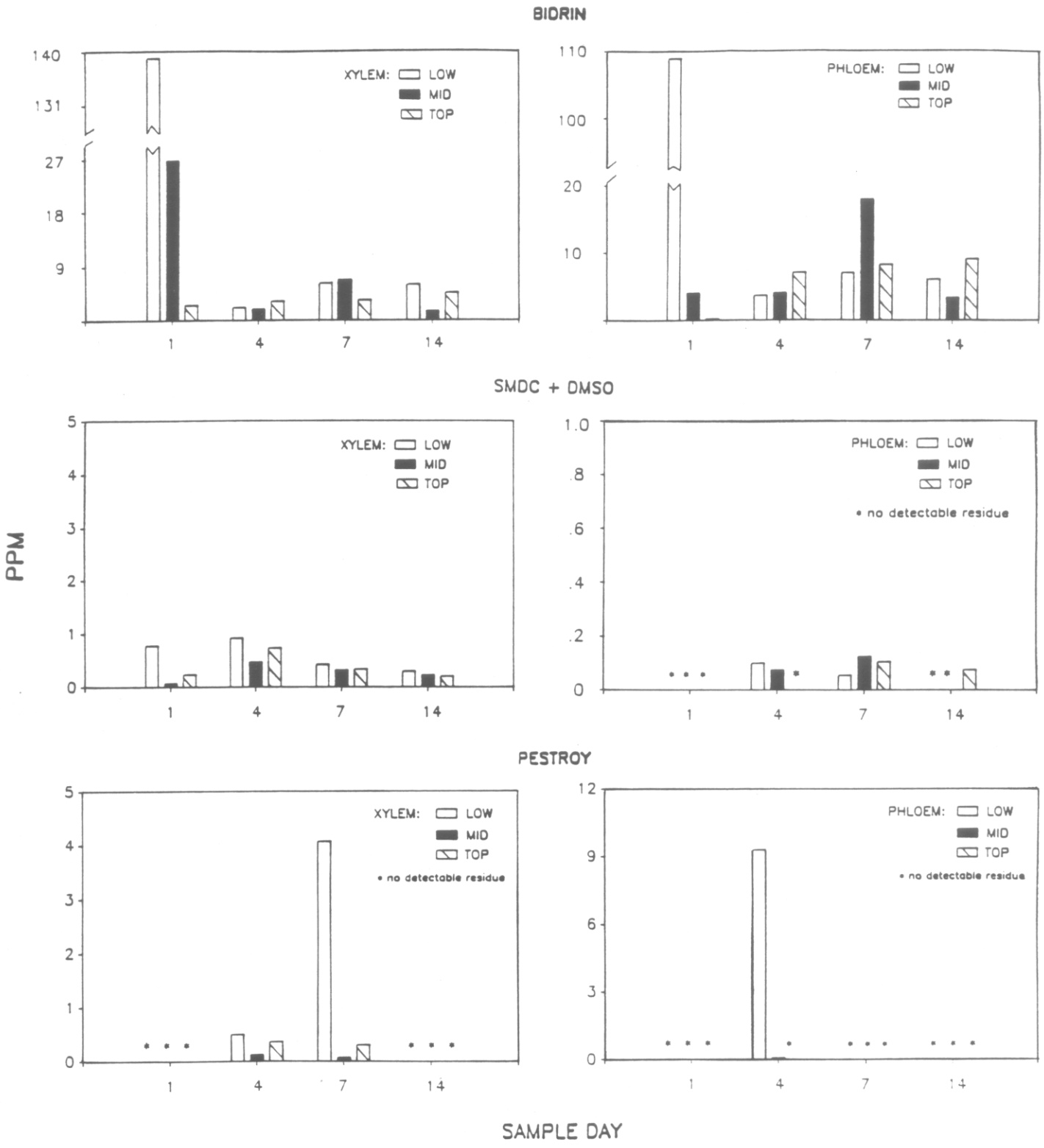

Figure 5 - Insecticide residues in treated pines on different days post-treatment at 3 heights, Spring 1987.

In 1988, intensive testing of dicrotophos and SMDC/DMSO, both in bark hacks, revealed a slightly different pattern (Fig. 6). Dicrotophos was found in xylem samples in appreciable quantities from 5 hours through day 28. Phloem residues increased substantially between day 1 and day 4 then declined through day 28. Both xylem and phloem samples contained from 5-10 PPM active ingredient through day 70.

SMDC/DMSO residues (Fig. 6) followed a pattern very similar to 1987 trials. Xylem residues peaked early on day 1 then declined to trace levels by day 14. Phloem residues peaked on day 1 then declined steadily through day 14.

Peak dicrotophos residues were much higher then SMDC/DMSO, almost a 10 fold increase. Dicrotophos residues were consistently detectable up to mid-bole and occasionally in the top samples. SMDC/DMSO residues were found only in the lower bole. Generally higher residues found in 1988 are mostly due to improved sampling and refrigeration techniques.

CONCLUSIONS

This study shows that fenitrothion (Pestroy 'hack and squirt') did not prevent attacks or significantly reduce SPB brood production and therefore would probably be ineffective as a spot control technique. There was little evidence for translocation of the active ingredient based on phloem and xylem residues.

Dicrotophos in Mauget injectors or in bark hacks did not prevent SPB attacks. However, it moved readily within the tree, occurring in both xylem and phloem at all heights, and was sufficiently residual to substantially reduce SPB brood production. These qualities suggest some potential to slow or terminate SPB spot growth, but the relatively high mammalian toxicity of dicrotophos would probably prevent registration for use by the general public. The high labor and materials cost per tree for dicrotophos applied via the Mauget injectors suggests practicality only for high value trees. Also, although trees were protected for a period, they ultimately were attacked and killed. Preventive control with this system might require several retreatments.

The system combining SMDC and DMSO (Rotonicide) did not prevent attacks but may have some potential as a spot control technique. However, it is not registered for use at this time. It is relatively easy and economical to apply via bark hacks. Since SMDC residues dissipate quickly, the effect on SPB is apparently from induction of defensive compounds in the tree and not by toxicity of the injected chemicals.

Pines injected with SMDC/DMSO are frequently attractive to attacking beetles for a short time due to copious production of oleoresins, often manifested as beads of resin on the outer bark. If significant attraction occurs prior to sufficient production of defensive chemicals and resin soaking of the phloem, this method could actually exacerbate SPB infestations.

The systems using dicrotophos, SMDC/DMSO or some other chemicals applied by injection into bark hacks should be investigated further to determine if they may eventually be incorporated into bark beetle management programs.

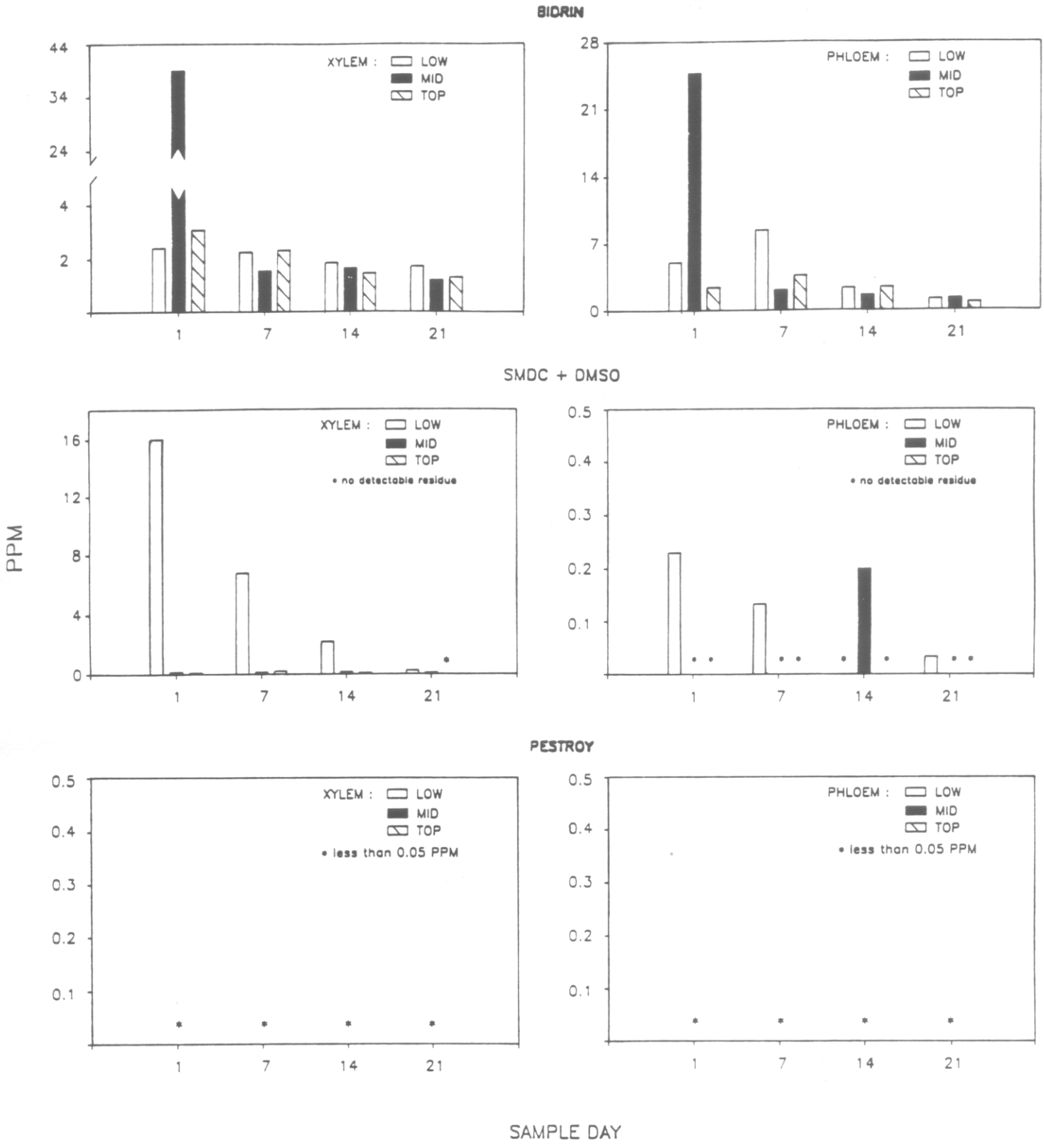

Figure 6. Insecticide residues in treated pines on different days post-treatment at 3 heights, Summer 1987.

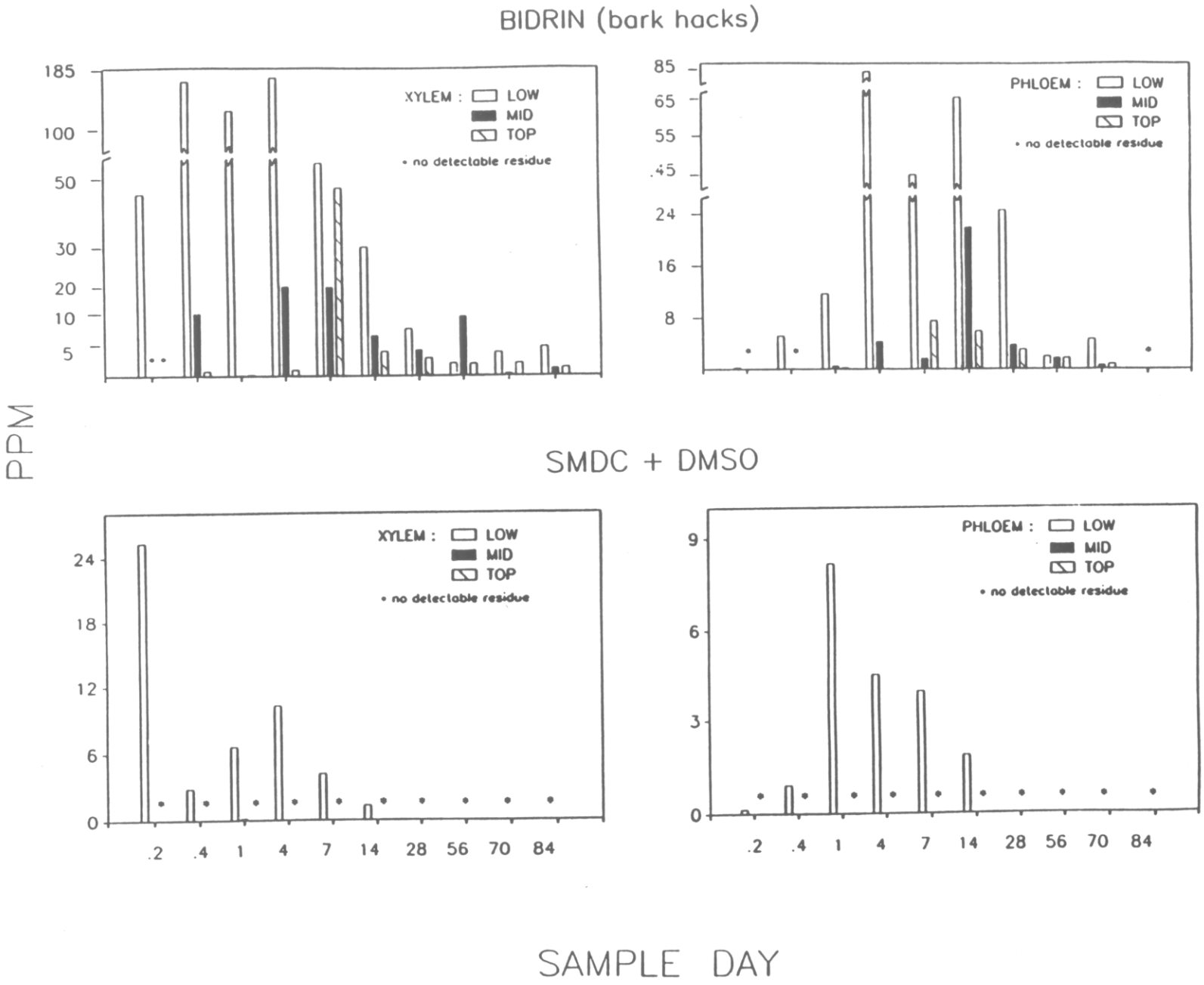

Figure 7. Insecticide residues in treated pines on different days post-treatment at 3 heights, 1988.

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